Topographic Waves on Slopes

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LONG-TERM GOALS

I seek to understand the influence of midlatitude jets on the surrounding ocean. The interrelations between meandering, radiation of low frequency energy and resulting mean flow generation have been of particular interest and relevance to my recent work. In this past year we have been focusing on the production of mean flows by shoaling topographic waves.

OBJECTIVES

The guiding hypothesis is that the meandering of western boundary currents acts as a wavemaker in the ocean. The meanders are quite depth independent and force mainly barotropic motions exterior to them. These motions propagate as low frequency Rossby waves and those to the north of the stream eventually become topographic Rossby waves as they begin to feel the bottom topography. I am studying the effects of nonlinearities and steep topography on these waves as they shoal and refract.

APPROACH

The results from an array of current meters, deployed in late summer of 1995 on the Continental Rise to the west of the Grand Banks, are the inspiration for this study (Hogg, 2000). Although an interpretation of the low frequency variability in terms of topographic Rossby waves was compelling, it was clear that a number of the implicit assumptions were violated: namely small amplitude waves and gentle slopes. In collaboration with Dr. Genta Mizuta, a visiting Japanese scientist, we have been using analytic and numerical methods (i.e. the Rutgers "ROMS" numerical model) to study this problem.

WORK COMPLETED

We have completed analytic and numerical work on the problem and have prepared a draft manuscript (Mizuta and Hogg, to be submitted).

RESULTS

We have found that significant longshore flows can be generated by Rossby waves which are obliquely incident on the Continental Slope and Rise. Although the waves become increasingly bottom trapped

as they shoal the resulting mean flow is only weakly depth dependent. Analytic solutions have been found which are in quite good agreement with the numerical experiments. Runs which are meant to be more realistic by including variable stratification and continuously varying topography show that longshore flows of order 20 Sverdrups can be forced by relatively weak (amplitude 2cm/s) Rossby waves. Our present work has two limitations: it allows only for dissipation at the bottom and considers topography with isobaths aligned zonally.

IMPACT/APPLICATIONS

This work suggests that radiation from western boundary currents can be quite effective at forcing longshore flows similar in transport to those observed. As the topographic waves become shorter and increasingly bottom trapped as they shoal it is not clear that this process is adequately reproduced in numerical models.

RELATED PROJECTS

None known to the PI.

REFERENCES

Genta Mizuta, and Nelson G. Hogg, in preparation: Three-dimensional structure of the circulation induced by a shoaling topographic wave.

PUBLICATIONS

Kyung-II Chang, Nelson G. Hogg, Moon-Sik Suk, Sang-Kyung Byun, and Kuh Kim, 2002: Mean flow and variability in the southwestern East Sea*, Deep-Sea Res. I*, 2261-2279. [published, refereed]

A. M. Treguier, N. G. Hogg, M. Maltrud, K. Speer, V. Thierry, 2002: On the origin of deep zonal flows in the Brazil Basin, *Journal of Physical Oceanography*, 580-599. [published, refereed]

HONORS/AWARDS/PRIZES

2002: Henry Stommel Research Award from the American Meteorological Society
2003: Elected fellow of American Meteorological Society.